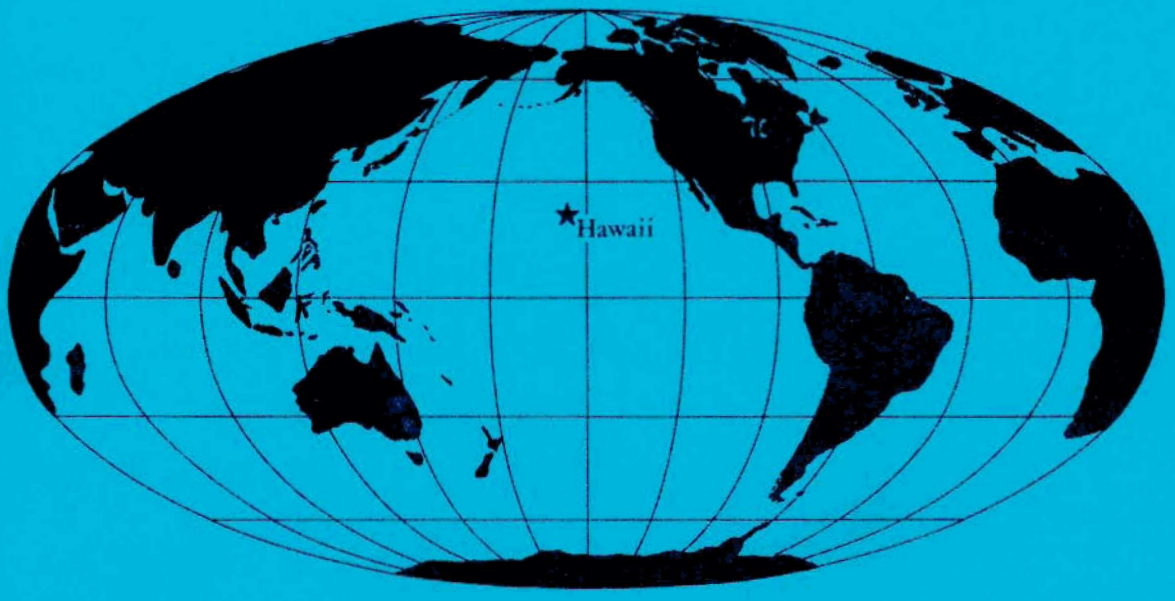
COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT

Hawaii

TECHNICAL REPORT No. 6

01-Year FINAL REPORT



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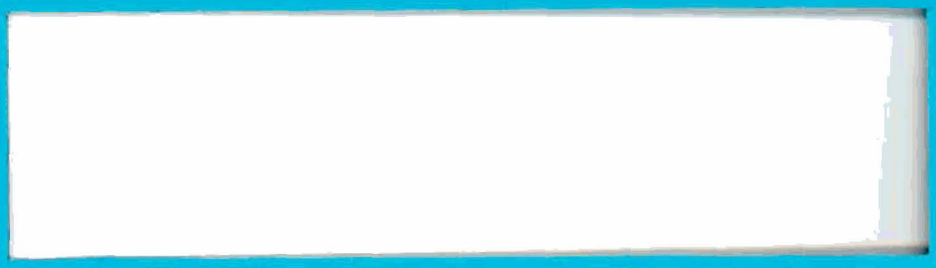

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TECHNICAL REPORT No. 6

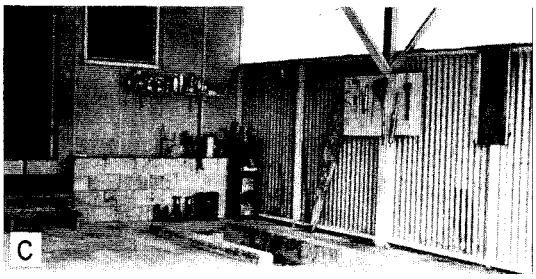
01-Year FINAL REPORT

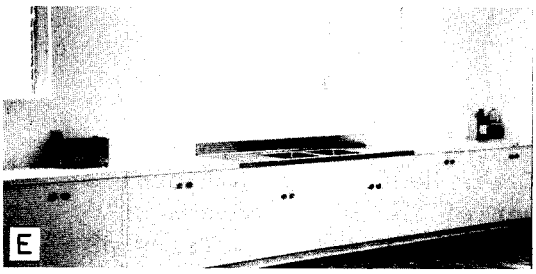
This report is issued for the use of the Western Region of the National Park Service and for the use of the Cooperative National Park Resources Studies Unit in fulfillment of the requirements of the related contract number 8092-0005-100 between the University of Hawaii and the Western Regional Office of the National Park Service. The transmission of the information in this report is the responsibility of Maxwell S. Doty, Botany Department, University of Hawaii, Honolulu, Hawaii, who is Director of the Unit. It has been compiled from field and conference notes primarily by the assistants Carole Packard, Fred Ball, Eddie Smith and others as mentioned in the text.

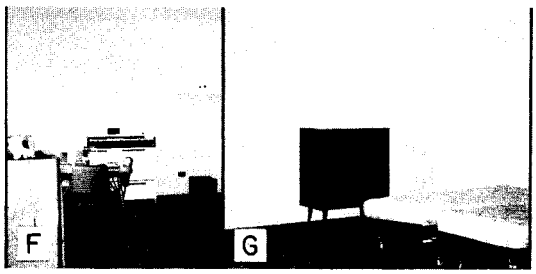
UH/NPS Unit

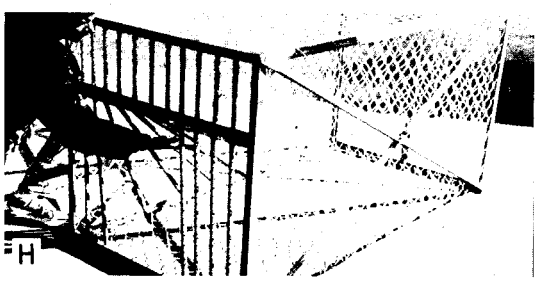
Cooperative National Park Resources Studies Unit

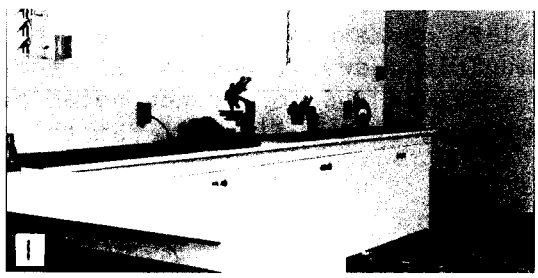
Completed 31 October, 1974











Frontispiece. Various scenes of UH/NPS Unit results during the 9 month-01-year. A- The Kau silversword in full bloom, one of the rare plants of concern located for study. B- The Hawaii Research Center, the development of which has taken a great deal of the UH/NPS 01-year funding and effort. The laboratory and vehicle maintenance building show beyond the jeep. The living facilities are in the building at the right. Details are shown in the following photos C, G & I. C- Maintenance of project vehicles is a constant problem eased greatly by the new facilities. D- The as yet scantily furnished day-room or lounge area. E- About 2/5 of the laboratory bench space in the new laboratory which, in addition, includes a storage room-office space. For those who notice the absence of faucets, the water is being installed. F- Dining and kitchen facilities are installed. These include refrigerators, sinks and cabinets not shown. G- Two small dormitories for men and women will sleep perhaps 20 when completely furnished. H- Devising traps and other ways of eliminating feral pigs is one of the serious problems of the Unit. Mr. Eddie Smith is shown here with one of the first models completed. I- Another view of the laboratory facilities available to those who are working on UH/NPS Unit-supported projects.

I. INTRODUCTION

Largely, the UH/NPS Unit's first half-year has involved a process of adjustment of personnel, the defining of goals and the recruitment and equipping of personnel for office and field operations. With the overlapping of the 02-year program, the staff, being involved in both, has been busy. Only the work projected in the First Progress Report for the 01-year is reported here. It is divided into the following sections:

II. Staff, personnel and organization

III. The Hawaii Research Center (Frontispiece)

IV. Development of other facilities

V. Progress on the 01-year a priori work plan

(Area A: Training for Scientific Park Resource Evaluation, Development and Management.)

(Area B: Descriptive Inventory of Natural Resources.)

(Area C: Biological Control and Carrying Capacities.)

(Area D: Basic Data Information and Advisory Systems.)

In the case of this last section, the arrangement of the First Progress Report is followed closely. However, several new projects were added and so are interspersed as appropriate. The information provided here presupposes the reader's knowing the contents of the preliminary report; otherwise reading this report should be done with the preliminary report in hand.

II. STAFF, PERSONNEL AND ORGANIZATION

The staff was increased to four and is now being reduced and will be two at the end of October as this report is completed. At its peak it

consisted of:

Mrs. Carole Packard, Administrative Assistant

Mr. Fred Ball, Field Assistant

Mr. Eddie Smith, Facilities Manager

Mr. Ismael Trono, Technician

This staff has been responsible for most of what is reported below with the work of others being specifically identified. The reduction in staff and the operational reorganization are being made in order to obtain more involvement by non-UH/NPS Unit personnel and to meet the different requirements of the 02-year. Funding thus released is being turned to more direct research support.

In order to develop a group of professional scientists having first-hand familiarity with Hawaii's National Parks, the interest of the following professionals has been elicited.

Principal Resource Group Personnel

Dr. Agatin Abbott	Dr. Charles Lamoureux
Dr. Andrew Berger	Dr. John Maciolek
Dr. Hampton Carson	Dr. Gordon MacDonald
Dr. Linsley Gressitt	Dr. Dieter Mueller-Dombois
Dr. Elmo Hardy	Mr. Saul Price
Dr. Philip Helfrich	Dr. John Randall
Dr. Alison Kay	Dr. Yoneo Sagawa
Dr. N. P. Kefford	Dr. William Theobald

In addition, the interest of a good many others has been solicited, e.g., those in a list of associated agency personnel and other University of Hawaii, Bishop Museum and professional government agency staff members.

Meetings have been held with the current members of the Resources Group and others in different combinations. Often these have involved NPS personnel. The initial such UH/NPS Unit meeting in April included leaders from t he Resources Group as well as the superintendents and staff members from the three Parks in Hawaii. The Chief Scientist of the Western Region, the State irector and the Director of the National Park Service Laboratory participated in this day-long meeting as well.

III. THE HAWAII RESEARCH CENTER

Use of the old Civilian Conservation Corps site as a research center has been initiated largely as per the plan originally advanced by the Park Research and the Bureau of Sports Fisheries Biologists. This was urged on the Unit by the general realization that (Frontispiece) laboratory facilities and more residential facilities were needed and by recognition of the Park's eventual need for the residences now used for these purposes.

The plan being followed was formed in conference with most of those whom we expect to be the principal users as well as with Mssrs. James K. Baker and Winston Banko and several Park staff members, including the Park superintendent. The former two provided the name, Hawaii Research Center. The work done is enumerated and figured below.

The activities anticipated as dominating the scene at the Hawaii Research Center are widely varied. Of them only some examples are given here. The purpose of their listing is to show the types of information felt by the UH/NPS Unit to be needed for management purposes and the variety of biological user interest.

The terminating International Biological Program (=IBP) leaves several research programs of value to the program of the UH/NPS Unit in an unfinished state insofar as some field work is concerned. Furthermore, certain parts of the basic support program of the IBP are being continued, e.g., studies of regeneration of the tree, Acacia koa, and monitoring of both weather at IBP climatic stations and the populations in enclosure areas where grazing by feral animals is prevented. This work and the management of vehicles and living quarters is being done by the UH/NPS Unit's facilities manager at Volcanoes who does this work under the direction of Dr. Dieter Mueller-Dombois, the present IBP director.

Learning the causes of species rarity or what may be endangering them was basic to the original proposal for this laboratory by Mssrs. Baker and Banko. The rare and endangered birds, the major purpose of the Bureau of Sports Fisheries' program in the Park, as well as the plants and insects, which are the major interest of the University group, require laboratory, aviary and propagation facilities. All these or space for these are being provided at the present site.

The site can serve as headquarters for the RBI-activities of Dr. Garrett Smathers and his National Park Service Science Center-based effort to develop a more sophisticated system of access to the complex natural history of the Parks.

Restoring the native plant populations is a major activity of the Park's wildlife management program. For this purpose, a plant propagation facility, largely a greenhouse, had been planned to go elsewhere. Now the installation has been resited for development at the Hawaii Research Center. Here its practical goals can follow closely the developments that are expected to emanate from the research programs at the Center.

To initiate development of the Hawaii Research Center, modification of two (frontispiece) of the old CCC-camp buildings has been initiated. At the same time, the Park Service has undertaken to improve the remainder of the buildings for use of large groups that will have short-term objectives in the Parks such as the Job Corps and various other educational groups. The ground plan (Fig. 1) shows the relationship of the buildings, the grounds and the surrounding mixed forest dominated by Metrosideros, the dominant Hawaiian forest tree. This site is about one mile from Park Headquarters and southeast of Kilauea Caldera between the Crater Rim Road and Kilauea Iki. At present, the carpentry and painting are completed. Contracts have been let for the plumbing and electrical work and, as an 02-year project, this should be completed during the coming month.

Planning the operation of the UH/NPS Unit's part of the Hawaii Research Center is under way. The next step is to negotiate arrangements for maintenance and utilities. Their cost will probably largely be spread in turn among the individual projects using the facilities, but the precise way this will be done has not yet been decided. The IBP program plans to move to the Hawaii Research Center as soon as these last details are settled.

IV. DEVELOPMENT OF OTHER FACILITIES

To facilitate work on Kipahulu Valley, a field laboratory and means of transportation was obtained by the purchase of a 19-foot camper mounted on a 3/4-ton truck. This has been used only in some initial exploratory work thus far and has proven very satisfactory.

The facilities at the University for a technician who will do illustrating, laboratory preparation and some instrumentation work have been

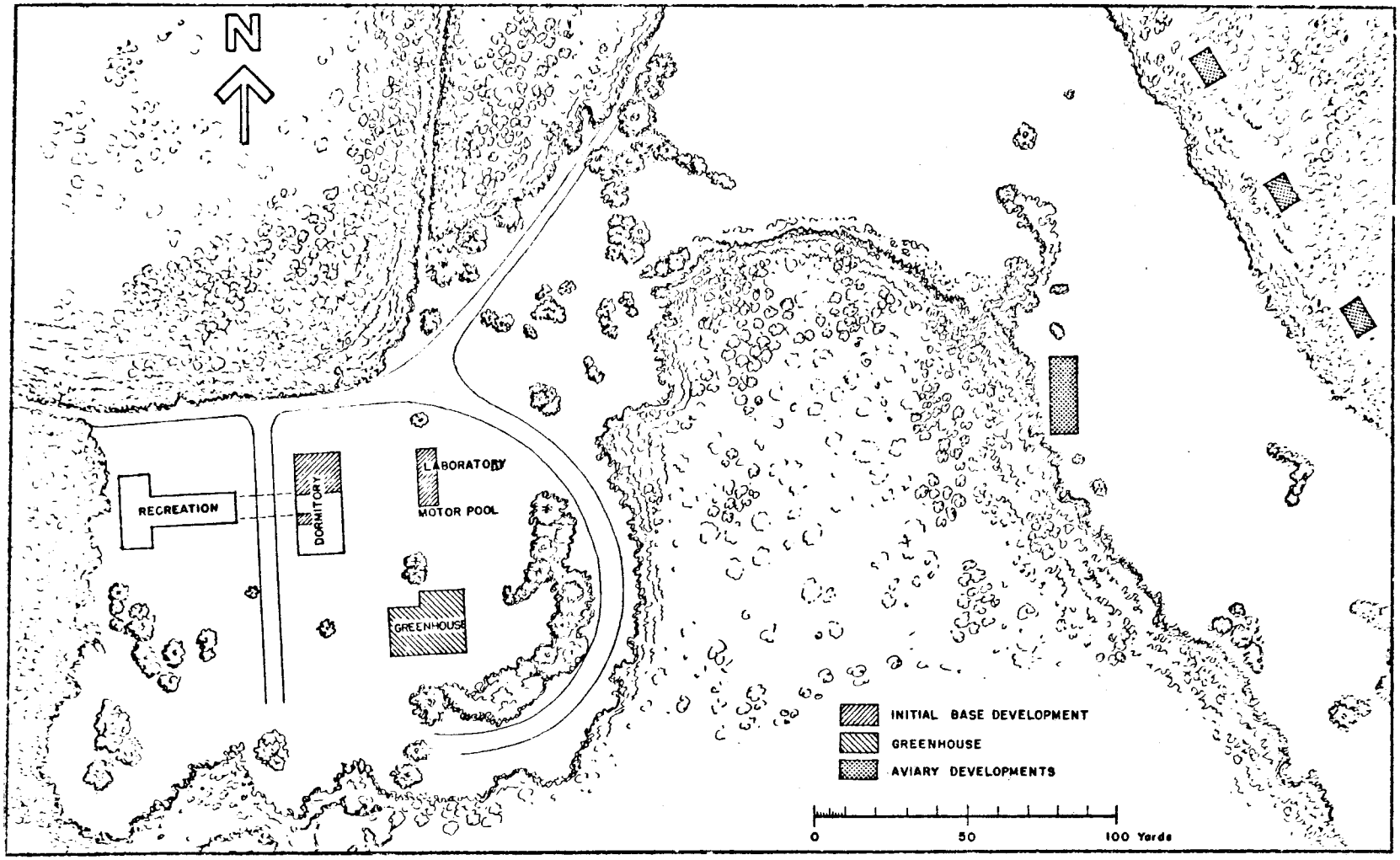


Fig. 1. General layout of Hawaii Research Center and associated structures.

improved. This has meant purchasing of equipment, but little beyond drawing instruments and materials. Several have availed themselves of the services of the technician thus far and this seems to be a satisfactory facet of our operations.

Office equipment has been obtained, stationery printed, telephones installed and the following reports produced:

No. 1 First Progress Report 01-year

No. 2 Berger: Bird Proposal

No. 3 Mueller-Dombois: Ohia Dieback Proposal

No. 4 Mueller-Dombois & Fosberg: Vegetation Maps of Volcanoes

No. 5 Cary: Plant Check List for Volcanoes

No. 6 01-year Final Report

V. PROGRESS ON THE 01-YEAR A PRIORI WORK PLAN

The "01-year" has actually been February through mid-October, a period of eight and a half months. During this period, consideration has been given to the scientific program for each of Hawaii's National Parks. The purpose of this work plan has been to engender activity. The approach of the 01-year contract has been mostly encouraging members of the Resources Group to move toward the study of such problems as appear in the following list. In some cases, provision or development of needs in the way of facilities or methods has been the approach. The results of this activity will appear mostly in reports on the 02-year contract.

AREA A

TRAINING FOR SCIENTIFIC PARK RESOURCE EVALUATION, DEVELOPMENT AND MANAGEMENT

The certificate program in resource management is the special project of Dr. Charles H. Lamoureux. It is presently being reviewed by select members of the Graduate Faculty. Once consent is obtained collectively from this group, a formal course proposal will be submitted to the Graduate Council for their perusal and approval. Receipt of approval is anticipated to occur by January of 1975, in which case the program could be implemented the following September at the earliest.

AREA B

DESCRIPTIVE INVENTORY OF NATURAL RESOURCES

a. Plan and, as feasible, initiate a study of Kipahulu Valley

See Area C, items a. and e.4 below, on carrying capacity and pig control, and Area D, items c. and d. below.

The concern for determining carrying capacity and for preserving the relatively pristine nature of Kipahulu has been the subject of several informal meetings. It seems clear an immediate effort should be made to reduce and remove the feral animals. The use of horses in the area is thought to be the most likely avenue of exotic plant invasion. The remote nature of even the more accessible lower end of the valley led to purchase of a mobile laboratory and field headquarters in the form of a 3/4-ton truck and 19-foot camper. This facility has been used on but two occasions thus far, but with considerable success.

The careful approach to obtaining management recommendations for Kipahulu Valley have led the UH/NPS Unit to view with favor the idea of

developing methodology outside Kipahulu rather than risk damaging mistakes within it. The NSF-sponsored undergraduate student studies in the nearby Waihoi Valley and in the Upper Hana Rainforest should provide considerable guidance. Their reports are not yet finished.

In the meanwhile, Mrs. Ruth Gay is anticipating a January, 1975, visit to both Kipahulu and the NSF-student study areas. Her objectives are to obtain first-hand familiarity for planning purposes.

b. Prepare in quantitative terms descriptions of the Hawaiian ecosystems. Historic changes will be included.

A synthesis volume is currently in preparation which will include all projects and data associated with the IBP studies conducted primarily at a few sites between 4300 and 6700 feet elevation along the transect formed by the Mauna Loa Truck Trail. Other ecosystem studies are in progress elsewhere, including some being planned for marine areas.

Maps as overlays to a reduced set of topographic maps have been prepared. These form Technical Report No. 4 of the UH/NPS which has just been distributed as authored by Drs. Dieter Mueller-Dombois and F. R. Fosberg. The purpose of Technical Report No. 4 is to provide working copies of this information of the appendix to Doty & Mueller-Dombois, 1966, "Atlas for Bioecology Studies in Hawaii Volcanoes National Park" of which only two copies were prepared initially. It is anticipated this will promote quantification descriptions of the Park ecosystems.

Operation of four weather stations containing apparatus for measuring relative humidity and rainfall as well as temperature located along the Mauna Loa Strip Road between the above elevations is being continued to gather more quantitative data on the Volcanoes ecosystems. Another is in the Kilauea Forest Reserve nearby and all are manned by the UH/NPS site

manager. The data from these stations are collected every Monday and forwarded to Dr. Kim Bridges at the University of Hawaii and Dr. Bridges incorporates them in the computer-based data bank.

c. List the rare, endangered and interesting plant and bird species of Hawaii through cooperative programs to be sought with the State Division of Fish and Game and the Bureau of Sport Fisheries and Wildlife. The same will be done in time for other groups of organisms and phenomena.

Plants: work ongoing, aided in part by Dr. F. R. Fosberg of the Smithsonian Institute, who has submitted a list of Hawaii's rare and endangered plants. This is being published by the Pacific Tropical Botanical Gardens and should be available soon.

Insects: the UH/NPS Unit has been reorganizing and typing the current list of rare, endangered and believed-extinct species. This 9-page list being prepared and edited by Wayne Gagne of the B.P. Bishop Museum, is not at all final, but at present 308 species are listed. While not for publication, it is included as Appendix No. 1 to this report. Drs. Hampton Carson and Elmo Hardy are continuing their studies of the insects in Hawaii Volcanoes National Park and will concern themselves for certain of the rare species. They will be utilizing the Hawaii Research Center facilities.

Birds: the work of Dr. Sheila Conant is expected to continue. She will be elucidating the biology of the endemic species and has prepared a proposal for the financing needed. Likewise, we anticipate both she and Dr. Andrew Berger will be using the Hawaii Research Center facilities at Volcanoes and the Mobile Field Headquarters at Haleakala. Dr. Berger submitted a preliminary proposal for study of the Volcanoes birds and is

now revising this in more definitive terms in reference to the objectives. He has just been involved in meetings with Washington, D.C., and with local Bureau of Sports Fisheries personnel on the needs for reconstituting the Hawaiian native bird populations. His work is expected to concern itself with such exotics as Mergilo and Leiothrix, both aggressive species bound to have an effect on the native bird populations.

The objectives of these ornithologists is to obtain the standard ecological and breeding biology information on each of the native and threatening exotic birds. There are at least 67 points of breeding biology information needed for each of the 26 Hawaiian species for which adequate knowledge is necessary for population management and, as indicated, restoration. Very little of this information is available now and interference at any point could mean endangerment to the species or may now be the reason such species are endangered or rare.

d. Complete revision of plant checklists and herbarium updating for H.V.N.P. & Haleakala National Park.

Under the direction of Dr. William Theobald, the herbaria of both Haleakala and Volcanoes were brought to the Botany Department at the University in Honolulu, updated nomenclaturally, repaired and relabeled as found desirable. They have both been returned to the respective Parks.

At present, the Hawaii Volcanoes National Park herbarium contains approximately 1550 specimens, most of which are from various parts of the Park area. The remaining are from areas outside the Park on the Big Island itself, or from one of the other major islands. These specimens include about 192 ferns and fern allies, 5 gymnosperms, 303 monocots and 1050 dicots. They are arranged alphabetically by family within the major groups. Except for a few recent collections made by Dr. C. H. Lamoureux

mainly in the Kipuka Puaulu area in the 1960's, most of these collections date from the 1930's and 1940's. The latter were made by workers such as G. E. Olson, H. Moreley, G. O. Fagerlund, R. L. Fowler and A. L. Mitchell.

Virginia Carey, utilizing the current prototype data system whereby the data are on magnetic tape, is producing the anticipated revised checklist of the Park plants. This, as Technical Report No. 5, is expected to be distributed shortly. As can well be anticipated, such a list will have to be revised many times before becoming at all stable.

A survey of the collections in the Park herbaria revealed the need for extensive new collections to obtain as possible any recent introductions, yet undescribed species or varieties and range extensions; as well as a better understanding of the distributional patterns of the Park plants in general. Also, more recent lava flows and animal disturbances have probably changed various aspects of the flora. This is a rather long term project now under way under Dr. William Theobald's direction.

In order to facilitate the preparation of these systematic collections and avoid repetition of what has already been collected by earlier workers, known localities were plotted on 1:24000 topographic maps of the area. As suspected, these revealed that most of the collections had been made in just a few isolated or convenient areas of study. These few include Kipuka Puaulu, Kipuka Ki, Kipuka Nene, Hilina Pali and the Park residential area. Most of these collections have been listed in Doty and Mueller-Dombois (1966) before. As a result, it was decided that a general plant collection should be made covering as many areas of the Park as possible before attempting to prepare a new list adding just the few collections that have been made since 1966. A new master list will be prepared

at a later date when all of the accumulated data can be analyzed. Whenever time permitted, collections were also made in areas adjacent to the Park and, though not a part of this project, on other parts of the island.

During the time in the field this summer, daily and 2- to 3-day trips were made over much of the area. On one occasion a helicopter was made available by the Park Superintendent, Mr. Bryan Harry and ranger, Mr. Donald Reeser for a trip to the Puu Keone area. On weekends, several trips were also made into the Olaa Forest Reserve, the Kilauea Forest and the forests along the Saddle Road for comparative study. Many native and introduced taxa have been collected with new distribution records obtained. In all, some 500 collections were made, increasing the total number of Park collections by over 33-1/3 per cent. Five to six duplicates were collected of each species for distribution to various other institutions including the University of Hawaii, Department of Botany, the Bishop Museum and the Smithsonian Institution as well as the Park herbaria.

The collections made for the Park and University herbaria are in the process of being mounted on herbarium paper and as of now over 300 specimens have been prepared. In addition, since there were no herbarium collections of mosses in the Park herbarium, these too were collected. About 75 such collections have been made and a set of these will also be deposited in the Park herbarium. Identification and typing of labels will be done in Honolulu with the use of Bishop Museum and University of Hawaii herbarium and library facilities. In the field, many color photographs of plants were taken that could later be of value for demonstration purposes.

At the beginning, many problems had to be faced due to the lack of equipment such as corrugated boards, presses, straps and the dryer needed for the proper care of the plants collected. However, these problems were overcome with provision of the necessary supplies from the Department of Botany, University of Hawaii. It was decided to have a dryer made through the Park services carpentry workshop, to specifications provided. With such essential equipment in hand, it was possible to carry out the work smoothly and efficiently.

As mentioned earlier the specimens in the Park herbarium are arranged in alphabetical order by family within groups such as fern allies, ferns, gymnosperms, monocots and dicots. No attempt was made to rearrange them into any other system of classification. However, it was thought best to follow Dr. W. H. Wagner's system of classification of the Hawaiian Pteridophytes rather than to leave a great number of taxa under the one major family, Polypodiaceae. New family folders for these taxa were made and new family name cards for all families of ferns, monocots, dicots, etc., were made in order to facilitate their quick and easy finding. Work was also started on an inventory of the fern and fern allies specimens in the herbarium. The data on the specimen sheets were transferred to 5" x 8" catalogue cards. These will be used in the near future to produce a checklist of the ferns and fern allies found within the Park.

Three further needs were expressed by the UH/NPS Unit's botanists. First, in order to further update the herbarium and assure there being complete reference collection of the plants found within the Park, more collecting is needed. Second, once completed, the inventory of the plant specimens available in the herbarium should be maintained. Finally,

it was also felt a reference library should be maintained with the herbarium.

e. Describe the City of Refuge fish populations and sketch a plan for their presentation to the public.

Dr. Leighton Taylor of the U.H. Cooperative Fisheries Unit and other ichthyologists propose to conduct a survey of the fish populations of Honaunau sometime in November. A proposal to obtain support for this work has been drafted for modification and submission to obtain funding for the study which must cover the seasons adequately to provide information that will be reliable for management decisions. The costs of this study are beyond the limits the UH/NPS basic funding will allow.

With Dr. Arthur Reed of the University Zoology Department, consideration is being given to ideas for interpretive presentations of the fishes used by the old Hawaiians.

f. Begin the location of stocks of the rare, endangered and interesting species of Hawaii, describe their status and initiate investigations of their propagative biology and natural reserve requirements, seeking to make this a coordinated effort with such agencies as the State Division of Fish and Game, the Bureau of Sport Fisheries and both the Lyon and Pacific Tropical Gardens.

Studies are under way by a goodly number of competent individuals and agencies. The UH/NPS Unit is restricting itself to the Park areas and immediate environs. The work reported above under "point d." identifies some of the effort. However, a special effort is being made in respect to the Kalapana Extension to extend and refine our knowledge of the stocks of rare, endangered and interesting species that might be lost by housing developments therein.

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Rare plant seeds have been distributed to the Lyon Arboretum and the Pacific Tropical Botanical Gardens, e.g., from the patches of Kau silverswords. These were found in flower by the UH/NPS site manager during an early September, 1974, visit to the Kau Mountain area. The silverswords were abundant there and (Frontispiece) in full bloom. The site manager also visited the sites of the three trees of Hibiscidelphus hualalaensis known to exist in the wild. One was dead, one nearly dead and one in seemingly good condition. Seed was collected and distributed to the Lyon Arboretum.

g. Determine and define the factors determining the territoriality of the endemic Hawaiian birds of Hawaii's National Parks.

The work of Drs. Sheila Conant and Andrew Berger is expected to provide territoriality information as their work proceeds; though little specific progress can be reported here. Information on the ranges of birds has been extended by Mr. Eddie Smith, the UH/NPS Unit's facilities manager at Volcanoes. He has discovered on Keaoi Island at Halape in Volcanoes what appears to be a new nesting site of the shearwater. Live young were found (Fig. 2) outside the nests. Rather than burrowing here, the birds appear to have (Fig. 3) utilized cavities in the pahoehoe lava as nesting sites. This extension of range is to be reported in the literature by Mr. Smith.

Figure 2 (above). A nestling of the shearwater on the mat of Sida fallax and photographed by Mr. Eddie Smith outside the nest on Kaoia Island October 3, 1974.

Figure 3 (below). Entrance to the lava-blister cavity in the rocks on Kaoia Island in which the shearwaters were discovered nesting.

AREA C

BIOLOGICAL CONTROL AND CARRYING CAPACITIES

a. Recommend carrying capacity for visitors in some key areas.

Mrs. Ruth Gay of the U.H. Botany Department is planning a study of trail recovery in the Hana Rainforest and Waihoi Valley regions. The results of such a study will presumably provide valuable data applicable to the adjacent area of Kipahulu Valley. Such a study must extend over a period of several years and it will involve, perhaps, two site visits per year. It takes two to three days to get to the sites and return. The weather cannot be predicted and thus, with preparation time, at least four weeks per year must be budgeted along with special light gear. A proposal for a continuing study of the Hana/Waihoi areas will be submitted soon after an initial survey is made, perhaps in January of the coming year. No readily accessible place can be used for gathering this needed visitor impact information for there is no accessible site comparable.

Carrying capacity consideration has been given to the following sizeable list of sites. Some of these have been selected by Mrs. Gay for their possibilities as study sites.

PRELIMINARY LIST OF AREAS CONSIDERED FOR HUMAN CARRYING CAPACITY PROJECTS

City of Refuge

Areas	Observations on Governing Factors
Palace Grounds	Biological: loss of ground cover; destruction of planted vegetation which blocks off former pathways.
Picnic Area	Biological: loss of ground cover resulting in erosion; possible enhancement of koa haole by human disturbance.
Grass Island in Parking Lot	Biological: invasion of natal redtop into planted pili grasscover as related to trampling.
Intertidal Zone	Biological: reduction of shell and urchin populations by collectors
Offshore Marine Habitats	Biological: reduction of coral and ornamental fish populations by scuba divers, snorkelers and other collectors.
Honaunau Bay	Biological: change in diversity and amount of marine life from pollution by nearshore dwellings and from boat anchoring and launching activities.
Fish Ponds	Biological: problems in establishing and maintaining a desirable fish population in this high use area.
	Quality of experience: reduction in aesthetic appeal by litter, sedimentation and general pollution.
Archeological Features	Physical: weathering of rock structures.
High Density-Use-Areas with Tree Cover	Visitor safety: injury from coconuts falling from mature, thin-trunked trees which are difficult to prune.
Hale O Keawe and Other High-Use Areas	Quality of experience: crowding during high-use periods by tours or other large groups.
	Biological: introduction of exotic plant disseminules by visitors.

Hawaii Volcanoes National Park

Areas	Observations on Governing Factors
Kipuka Puaulu	Biological: impact on birds, rare plants and cave life.
Red Hill Cabin on Mauna Loa	Biological: predators attracted by human garbage in vicinity of dark-rumped petrel breeding sites.
Olaa Forest	Biological: impact on ground cover and epiphytic regeneration in wet forest.
Devastation Trail	Biological: introduction of exotic plant disseminules.
Thurston Lava Tube	Biological: impact on trailside native plants; establishment of trailside exotic plants in trampled areas.
	Quality of experience: noise of crowds in lava tube.
End of Chain of Craters Road	Safety and quality of experience: traffic congestion and volcanic fumes.
Chain of Craters Overlooks	Safety and quality of experience: danger of falling; parking congestion.
Campground and picnic areas (Kipuka Nene, Namakani Paio)	Quality of experience: mixture of exotic and native plants; noise; lack of privacy when fully occupied.
Back country	Physical: limited water supply; damage to archeological features.
Bus routes	Quality of experience: crowding at Volcano House and Park Headquarters during lunch hours.
Halemaumau and Uwekahuna Overlooks	Quality of experience and safety: crowding and fumes during eruptions.
Kilauea Military Camp	Quality of experience: concentration of facilities and overnight visitors in relatively open landscape near caldera.
Steaming Cliffs	Physical, biological and safety: destruction of geological and biological entities and danger of falling in area easily accessible to Volcano House and KMC patrons.
Tree Molds	Physical: destruction by visitors.

Hawaii Volcanoes National Park (cont'd)

Areas	Observations on Governing Factors
Puuloa Petroglyphs, Mauna Iki Footprints, Kamoamoa Village, Wahaula Heiau	Physical: weathering, vandalism.
Sulphur Banks	Physical: trampling and collecting.

Haleakala National Park

Areas	Observations on Governing Factors
Summit Area	Biological: loss of scattered plant cover near museum and comfort facilities; attraction of petrel predators by human activities; trampling of petrel burrows.
Kalahaku Overlook	Biological: collection and trampling in silversword population.
Crater Trailsides	Biological: trampling around silversword populations; introduction of exotic plant disseminules by humans and horses leading to the replacement of native trailside flora by exotics.
Crater Campgrounds	Biological: direct and indirect impact on nene and petrel habitats; spread of exotic plants; impact of camping on native and exotic vegetation.
	Quality of experience: crowding at cabins and campsites.
Kipahulu and Upper Hana	Biological: establishment and permanency of exotic plant species; optimal frequency and intensity of trail use in terms of ground cover.
Seven Pools	Safety: swimming; diving.
Hosmer's Grove	Quality of experience: privacy, non-natural landscape.
Sandalwood Parking Space	Biological: specimen collecting.

b. Investigate the rare tree area of Kaupo Pali, Haleakala, to determine why the trees are not reproducing.

It is recognized that experiments are needed to determine tenability of Dr. N. P. Kefford's hypotheses set forth in Technical Report No. 1, the Preliminary Report. This project has languished to date for, in comparison to others, it seems to have far less urgency.

c. Complete the Hiiaka fire burn study in Hawaii Volcanoes as a continuation of the work reported in the 1969 Office of Natural Science Studies annual report.

Because the region originally studied by Dr. Garrett Smathers is so altered by the 1969-current volcanic activity (See Fig. 4), there would be little continuity between that which has been already studied and any ensuing studies. Thus, Dr. Smathers has concluded this study.

A resume of information on the general area was prepared by Mr. Rick Warschaur emphasizing the species endangered within this general area of the Park. His various observations are listed under the following section headings:

1) Description of fireburn and vegetation
2) Effects of Fire
3) Damage and recovery
4) Exotic competition
5) Burned area sketches
6) Animals in survey area
7) Trees rare or uncommon in the survey area (there are specific subsections on: Alphitonia ponderosa, Antidesma platyphyllum, A. pulvinatum, Bobea timonioides, Dracaena aurea, Myrsine lanaiensis, Pelea radiata, Pittosporum spp., Rauvolfia

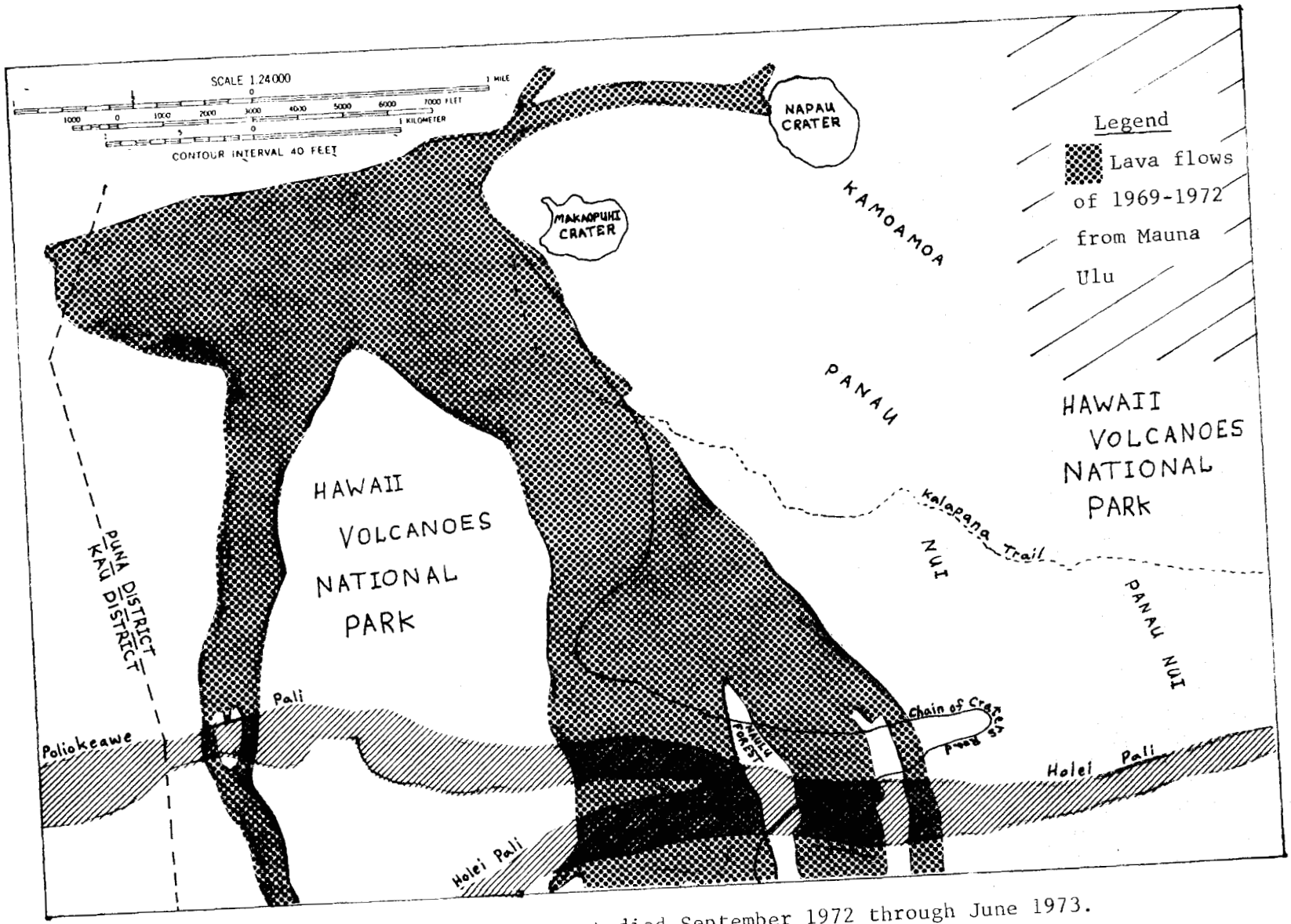

Fig. 4 Approximate boundaries of area studied September 1972 through June 1973.

sandwicensis, Reynoldsia sandwicensis, Santalum ellipticum Tetraplasandra hawaiiensis and Xylosma hawaiiensis.)

8) Notes on other plants

9) Recommendations for management concerning: a) 2500' Kalapana trail kipuka, b) Tetraplasandra area, c) First Kipuka Ka'u of Naulu, d) Naulu and e) other areas.

In the above, there are many subjects considered that will provide management direction. Some of this information will be of obvious value in making choices concerning fire control, whereby rare and endangered species should be given priority fire control protection far beyond that afforded the more common vegetative cover. The desirability of controlling exotic plants and feral animals, such as rats and pigs, is clearly expressed; goats currently pose no problem in this area.

Fires started from the Mauna Ulu-Alae lava flows, spread over large portions of the open Metrosideros forest in the survey area, mainly in a broad patchy swath down along and below the Kalapana Trail to Holei Pali, and out a bit from the flow edges. Mortality of Metrosideros was moderate to heavy, especially among the small- to medium-sized trees, and there was very heavy damage to native shrubs. The total effect was to provide much sunlit space and exposed soil. Because native shrubs are generally slow to revegetate such an area, many exotic species have been given a chance to get started, some incidently and others invasively. Additional pressures from goat browsing and pig digging make the revegetation process even more difficult and the soil further disturbed, possibly favoring the strong establishment of the hardier exotics such as Andropogon, Psidium and Lantana at the expense of the native vegetation elements.

A few endemic dry forest trees are now present in the Park in small numbers. Their locations within the survey area and adjacent range and their general associations with other trees have been noted for probable propagation considerations later. Seeds and a few cuttings were taken from these and other native plants.

It is recommended that Park Service efforts in management of the survey area emphasize control of noxious plants and feral animals, at least initially. Collection of propagating material from selected species and some planting should be done in a deliberate manner in carefully selected areas utilizing seed stock from that specific area.

d. Update and extend the vegetative dynamics of the 1959 Kilauea Iki eruption, recording trends since 1968 of a successional nature.

A publication resulting from this study by Drs. Dieter Mueller-Dombois and Garrett Smathers will be issued soon through the National Parks Science Center.

e. Other projects as opportune to available personnel and time restraints.

1) Restore old Hawaiian fish ponds at City of Refuge

Most of the larger-sized Tilapia have been seined out of the fish ponds; carnivorous species of fish were introduced to further reduce the remaining stocks of Tilapia. However, this latter method has not been successful; hence, the ponds will be filled with sand. Later, the sand can easily be removed. The ponds, being small, can be handled this way relatively inexpensively. Their extremely irregular hole-filled lava shores prevent success of many more obvious procedures.

2) Set up a microfilm library of pertinent documents, reports and articles for the Hawaii National Parks with accompanying indices.

Ms. Frances Jackson, U.H. Archivist, has been working on a Hawaii National Parks bibliography list with reference to reports of all types. She is submitting a list of bibliographies concerning the natural history aspects of Hawaii's National Parks. Along with this, the UH/NPS Unit is cooperating with a computer storage and recall bibliography development of Dr. Kim Bridges. This is a part of the computerized data system, the specific area of which is the ecological bibliography for the state.

3) Monitoring of vegetation recovery in goat exclosures in Volcanoes and on Puu Hualalai.

On 21 June 1974, a trip to Hualalai was arranged with Mr. Norman Carlson, representative of the Bishop Estate owned land, in order to view several goat and sheep exclosures constructed on the property. Two members of the UH/NPS Unit's staff participated. Most notable about the one-to-one-and-a-half-year-old exclosures is the extensive cover of vegetation exhibited within, compared to the paucity of vegetation external to, the exclosures. A monitoring program has been established for this region regarding rates of natural succession and diversity of plant species, a study which will be of value to similar monitoring programs now extant at Volcanoes.

4) Pig control methods relative to Kipahulu Valley.

Contact was made with Haleakala National Park officials for discussions on pig control at Kipahulu. The specific measures discussed included 1) shooting pigs on a continuous basis, 2) poisoning,

3) biological control and 4) trapping. Although the use of a selective baiting program using a poison would be the most effective in eliminating the pig populations, the impact of it on the environment in general must be considered. Possibly, the best alternative method is to make use of trapping techniques. Presently, a trap has been developed (Fig. 3) and tested in Kulani Forest near Volcanoes where pigs also constitute a problem with the native vegetation. Other methods do not promise more than lowering the populations. Preparations for application of pig control methods and their development have been discussed variously (see above, e.g., in describing provision of field facilities on Maui Island).

Quite frankly, the UH/NPS Unit is concerned that trapping or hunting could quite possibly be as damaging to Kipahulu through introduction of exotics as it would be protective in stabilizing the pig populations at a lower level. It is reputed that hunting in the lower part of the valley encourages the frequent release of excess domestic pigs. The use of poison of selected nature could remove the pigs completely with no other significant effects. This, with elimination of hunting and some fencing could safely eliminate pigs as a threat to this very rare native Hawaiian vegetation.

5) Goat control program for Haleakala.

It is not certain if goats constitute a significant problem, since 1) no reliable estimates of goat population are available and 2) no quantitative data are at hand pertaining to silversword reduction by goats. In the latter instance, it is felt by the Park's personnel that visitor impact has a greater influence on silverswords than have the goats.

Furthermore, there is an interest on the part of the Park employees and local citizenry in preserving the tradition that has arisen, of course in European times, of these herds being available to hunting. In any case, the populations are low and reputedly kept stable by hunting.

The few goats in the grassland between the Upper Hana Rainforest and the Park should be eliminated as soon as possible and should be prevented from becoming re-established.

6) Rat and mongoose problems at Haleakala.

Both rats and mongooses have been observed to feast on the eggs of the petrel, a burrow-nesting sea bird. Since the petrel lays only one egg each year, in time, the influence of rats and mongooses may have a marked impact on their populations. Currently, small-scale monitoring of certain active nesting sites is being conducted by Haleakala National Park personnel. It has been suggested, however, that more detailed research be devoted to this problem by professional personnel from the University of Hawaii.

7) Exotic plant control at Haleakala.

Currently, there are attempts to restrict the spread of ironwood trees, primroses and other exotics by removal. Primroses, in particular, tend to be the greatest nuisance and most widespread of the exotics at Haleakala. This is largely a case of management manpower being available.

8) Goat control at Volcanoes

Goat populations at Volcanoes have been reduced through continued hunting and goat drive/capture methods in the fenced areas. This is a splendid example of good Park management. Complete eradication of the goats may not be possible, however, due to various population

pressures and logistical problems. It is unlikely that the few goats remaining will have a significant impact on the environment's vegetation and they can be moved eventually.

9) Ethnobotany

The Lyon Arboretum will be publishing a book on Hawaiian Ethnobotany, the illustrations being provided, in part, by the UH/NPS Unit. This material was formerly only available as compounded into booklet form from sheets handed out in the classroom. It is anticipated the work will be of value to the interpretive efforts of the ranger-naturalists. It should also assist in management and, in the case of Puukohola Heiau, resotration of the Hawaiian scene where a need for such information has been expressed.

10) Phenology of Acacia koa

The regeneration or reproduction responses of koa to feral animals, exotic insects and other changes wrought by man is critical information for Park wildlife management. Thus a recently initiated UH/NPS project has been the continuation of an effort initiated by the IBP project. One hundred eighty koa seedlings, located in the Kilauea Forest eserve have been marked and placed in five separate classes based upon size. Initial notes on substratum, canopy covering, light exposure, plant condition, height and whether the particular plant was a seedling or sucker were recorded. Regularly recorded information includes data on insect, pig and rat damage. These seedlings are monitored every three months and the project is anticipated as continuing for a period of five years.

11) Phenology of Metrosideros colina

Every three months, 180 ohia seedlings are monitored in the same fashion as above and in the same area as the koa seedlings.

AREA D

BASIC DATA INFORMATION AND ADVISORY SYSTEMS

a. Map the zones of high botanical values in the Kalapana Extension of H.V.N.P.

Transects, through the Kalapana Extension, are now being mapped for their biological values. This expansion of the coverage from just the botanical will not be completed until well into 1975 and since 02-year funds are being used for the work, no further report is provided here.

b. Advance toward completion of the geological mapping of Haleakala Crater N.P.

Dr. Gordon MacDonald recently completed the necessary field work. Part of the mapping has been completed covering in particular the outside slopes of the crater. This is in possession of the Haleakala N.P.S. staff in its preliminary form. The remaining mapping, largely the area inside the crater, can be completed in a very few weeks but it is very hard for Dr. MacDonald to get such suitably long free periods for the concentration necessary.

c. Begin preparation of atlases of bioecological information for the City of Refuge and Haleakala.

Beginning with the assembling of a few select bibliographies from local sources, these projects have begun. Further information on these areas, aerial photographs and geological data are likewise being gathered.

The above projects, "b" as well as "e" and "f" below and all activities recorded concerning Kipahulu Valley, the Upper Hana Rainforest and Waihoi Valleys (these latter, the NSF-sponsored student projects led by John Kargaard) are to either be combed for information or are being used for planning the 02-year activities on these atlases.

d. Begin integration of present IBP study data into an ecosystems computer modeling system.

The available data are currently being assimilated into a data bank at this time. The project in general is being turned over to the NPS Science Center otherwise. However, see next project.

e. Plan further stocktaking and initiate in-depth analyses of presently mapped ecosystems for in-depth modeling and predictive purposes, especially in respect to the Kipahulu Reserve as the initial step toward determining its optimal role in the Park system based on and assembling the presently available information.

The 02-year project will completely reorganize and, under a different organization, continue work toward this project's objectives. The UH/NPS Unit, as part of its 01-year program, is making Hawaii Research Center facilities and personnel available for rounding out or extending the IBP data. Much of this, including completion of the Hawaii Research Center facilities, is 02-year activity.

f. Develop descriptions and map the intertidal zone on Hawaii Volcanoes National Park coast.

An ad hoc marine resource committee has been formed to discuss and plan what should be done along Honaunau and H.V.N.P. coastlines in respect to the UH/NPS Unit's objectives. The committee now includes:

Drs. Dennis DeVaney, Phillip Helfrich, Alison Kay, Robert Kinzie, John Randall, Arthur Reed, John Stimson and Leighton Taylor; Mssrs. Robert Barrel (N.P.S. State Director), Robert Chamberland (N.P.S. architect), Eddie Smith (site manager, Hawaii Research Center, UH/NPS Unit) and Fred Ball (research associate, UH/NPS Unit), with Dr. M. S. Doty, ex officio.

The principal points discussed were: 1) initiation of an inventory of National Park aquatic resources along the coastline of Volcanoes and Honaunau; 2) development of an interpretive program concerning aquatic resources of Honaunau Bay and 3) the prospect of designing research projects regarding the marine environment in Volcanoes and Honaunau.

It goes without saying that this particular region features some of the most beautiful coral and associated biota in all of the islands; hence it would seem desirable to install a program at one of the Parks that will highlight them. However, this should be done in such a way that the end result will not detract from or be incongruous with the Park's main purposes which, at Honaunau, is emphasizing the historical.

Attempts to gain information about visitor carrying capacity, especially at such places as Honaunau and, to a lesser extent, Halape, are needed. A preliminary visit to Halape on the Volcanoes shore was made by Mr. Eddie Smith. This area may be suffering from the impact of visitors who are endeavoring to live off of the land as much as possible. In addition, specific projects regarding the marine ecology of these areas and others within the N.P. boundaries should be welcomed. There is very little hard biological information known of the Volcanoes

coastline. A study of the Halape area completed by Mr. Vernon Brock and Dr. R. W. Hiatt has not been located. However, there are at least two earlier studies of the Honaunau area.

In respect to Honaunau, Dr. Leighton Taylor has prepared a proposal to enumerate and describe the ethology of the fish populations. Dr. Arthur Reed is particularly interested in interpreting the Hawaiian usages of invertebrates and fishes. There are initial plans for several members of the Resources Group to visit Honaunau in January in order to both fill some information gaps, introduce some members to the Park and initiate development of the 02-year scientific program for the Park.

APPENDIX 1

edited by Wayne Gagne, B. P. Bishop Museum

LIST OF RARE AND ENDANGERED (SOME POSSIBLY EXTINCT) SPECIES OF TERRESTRIAL ARTHROPODS IN THE HAWAIIAN ARCHIPELAGO

Because our knowledge of the insect fauna of the islands is still very incomplete and insufficient, and field and systematic studies on all groups of arthropods have not been extensively continued to date, it is difficult to determine what species are extinct, rare and endangered. The following partial list, therefore, can only be based on assumptions and was compiled primarily from (1) associations of native insects on rare, local or extinct plants recorded in the literature; (2) references such as Fauna Hawaiiensis, Proceedings of the Hawaiian Entomological Society, Forest Entomology in Hawaii and the Insects of Hawaii series; (3) collections in the Bishop Museum; (4) species formerly present in now obliterated ecosystems and (5) from consultations with local experts on the various groups.

AMPHIPODA:	Talitridae:	n.q.n.sp. Kauai cave amphipod Orchestia kaalae Barnard Kaala, Oahu at least 30 n. sp. endemic to Hawaii (about 1/4 world's talitrid fauna). Many spp. probably now extinct or so rare will be missed in current survey.
ARANEIDA:	Lingphiidae:	Meioneta gagnei Gertsch Maui ex lava tube
	Lycosidae:	Adelocosa anops Gertsch Kauai ex lava tube
		Lycosella hawaiiensis Simon
		L. kalukani Simon Kauai
		Syroloma minor Simon main islands
		S. major Simon
	Oonopidae:	Enjone styguis Gertsch Hawaii
COLEOPTERA:	Anobiidae:	Holcobius pikoensis Perkins Oahu on Drypetes phyllanthoides
		P. (Paraclytarlus) abnormis (Sharp) Hawaii on Metrosideros
	Cereambycidae:	Plagithmysus (Peleithmysus) alani Gressitt West Maui on Pelea
		P. (s. str.) annectens (Sharp) Kauai on Acacia koa
		P. (Neoclytarlus) bidensae Gressitt Hawaii on Bidens
		P. (Nesithmysus) bridwelli Perkins Oahu on Pelea
		P. (Neoclytarlus) claviger (Sharp) Hawaii on Acacia koa
		P. (s. str.) decorus Perkins Hawaii

COLEOPTERA: Cerambycidae:

P. (Aeschrithmysus) dubautianus Gressitt & Davis Maui
P. (Peleithmysus) ellus Gressitt Maui on Dubautia
P. (s. str.) elegans Sharp Hawaii
P. (Peleithmysus) forbesi Perkins Maui on Pelea
P. (s. str.) forbesianus Gressitt Kauai
P. (s. str.) fractus Perkins Molokai
P. (Peleithmysus) haasi Perkins Oahu on Pelea
P. (P.) greenwelli Gressitt & Davis Hawaii on Santalum
P. (s. str.) ignotus Perkins Kauai Eleaocarpus
P. (s. str.) koae Gressitt & Davis Maui Acacia koa
P. (s. str.) kohalae Perkins Hawaii
P. (s. str.) kraussi Gressitt & Davis Hawaii
P. (s. str.) kuhnsi Perkins Oahu Pipturus
P. (s. str.) lanaiensis Sharp Lanai Metrosideros
P. (Paraclytarlus) laticollis (Sharp) Maui on Acacia koa
P. (s. str.) longicollis Perkins Maui
P. (Neoclytarlus) mezoneuri (Swezey) Hawaii on Mezoneuron
P. (s. str.) muiri Perkins Oahu Ponteria
P. (s. str.) nihoae Perkins Nihoa Euphorbia
P. (s. str.) paludis Perkins Kauai
P. (s. str.) permundus Sharp Kauai on Bokea
P. (Paraclytarlus) pipturicola (Perkins) Maui on Pipturus
P. (s. str.) platydesmae Perkins Hawaii on Platydesma
P. (Paraclytarlus) podagricus (Perkins) Hawaii
P. (s. str.) polystictus Perkins Kauai on Cryptocarya
P. (s. str.) pulvillatus Karsch Maui on Metrosideros
P. (s. str.) rubi Perkins Maui on Rubus
P. (s. str.) simplicicollis Sharp Hawaii
P. (s. str.) simillimus Perkins Maui on Pipturus
P. (s. str.) speculifer Sharp Maui
P. (s. str.) sulphurescens Sharp Hawaii on Urera
P. (Neoclytarlus) superstes (Zimmerman) Oahu
P. (s. str.) swezeyi Perkins Hawaii
P. (Aeschrithmysus) swezeyi Gressitt & Davis Maui Argyroxiphium
P. (Nesithmysus) sylvae Gressitt W. Maui on Pelea
P. (s. str.) vicinus Sharp Hawaii on Pelea

COLEOPTERA: Cridae: Cis vagans Perkins Nihoa

COLEOPTERA: Curculionidae:
Deinocossonus nesiotes Perkins Oahu
Dryophthorus distinguendus Perkins Laysan
Dryotribus mimeticus Horn Laysan
Heteramphus filicum Perkins Oahu Cibotium spp.
Macrancylus linearis LeConte Laysan
O. odemus breviscopum Perkins Nihoa
O. erro Perkins Nihoa
O. laysanenis Fullaway Nihoa, Necker, Laysan
O. neckerensi Perkins Necker
Pentharthrum blackburni Sharp Laysan
P. pritchardiae Perkins, Nihoa

Rhyncogonus biformis Perkins, Necker
R. blackburni Sharp Oahu
R. bryani Perkins Laysan
R. exsul Perkins Nihoa
R. freycinetiae Perkins Oahu
R. giffardi Sharp Hawaii
R. keobelei Perkins Oahu
R. lahainae Perkins Maui
R. lanaiensis Perkins Lanai
R. molokaiensis Perkins Molokai
R. mutatus Perkins Oahu
R. obsoletus Perkins Oahu
R. oleae Perkins Oahu
R. segnis segnis Perkins Oahu
R. segnis fordi Zimmerman Oahu
R. sharpi Perkins Molokai
R. simplex gossypii Zimmerman Oahu
R. squamiger Perkins Kauai
R. stygius Perkins Kauai
R. sylvicola Perkins Kauai
R. tuberculatus Perkins Kauai
R. vittatus Perkins Kauai
R. welchii Perkins Oahu

COLEOPTERA: Dermestidae: Labrocerus n. sp. Necker Nihoa

Elateridae:
Eopenthes ambiguus Blackburn
E. arduus Sharp
E. auratus Sharp Molokai
E. celatus Sharp Molokai
E. cognatus Sharp Hawaii
E. debilis Sharp Oahu
E. deceptor Sharp Molokai
E. funebris Sharp Kauai

E. germanus Sharp Oahu
E. kauaiensis Sharp Kauai
E. muticus Sharp Kauai
E. pallipes Sharp Oahu
E. plebius Sharp Lanai
E. politus Sharp Maui
E. tarsalis Sharp Kauai
E. tinctus Sharp Hawaii
E. unicolor Sharp Kauai
Itodacnus noricornis Van Zwabuvenburg Necker
I. paradoxus Van Zwabuvenburg Necker

Histeridae: Acritus n. sp. Necker
Lucanidae: Apterocychus honoluluensis (Waterhouse) Kauai
Proterhinidae: Proterhinus abundans Perkins Nihoe
Proterhinus alyxiae Perkins Lanai, Molokai
P. antiquus Perkins Kauai
P. arhopalus Perkins Maui
P. asteliae Perkins Oahu
P. ater Perkins Hawaii
P. breviformis Perkins Lanai
P. bryani Perkins Nihoa
P. bryoniae Perkins Molokai
P. cognatus Perkins Kauai
P. comes Perkins Maui
P. compactus Perkins Oahu
P. coprosmicola Perkins Oahu
P. crassicornis Perkins Kauai
P. cristatus Perkins Oahu
P. cuneatus Perkins Maui
P. debilior Perkins Maui
P. debilis Sharp Oahu, Hawaii
P. desquamatus Perkins Hawaii
P. detritus Sharp Lanai
P. echinoides Perkins Molokai
P. elegans Perkins Maui
P. erythrodes Perkins Molokai
P. euops Perkins Oahu
P. euphorbiae Perkins Oahu
P. eurhopalus Perkins Kauai
P. eurhynchus Perkins Hawaii
P. fuscicolor Perkins Maui
P. gigas Perkins Kauai
P. hawaiiensis Perkins Hawaii
P. hemichlorus Perkins Maui
P. heterotarsus Perkins Molokai
P. homeochromus Perkins Kauai
P. humeralis Sharp Maui
P. impressiscutus impressiscutus Perkins Oahu

P. impressiscutus nudior Perkins Oahu
P. insignis Sharp Lanai
P. kahanae Perkins Oahu
P. kamptarthrus Perkins Oahu
P. lanaiensis Sharp Lanai
P. laticollis Blackburn Oahu
P. laticornis Perkins Kauai
P. lecontei Sharp Maui
P. leiorhynchus Perkins Oahu
P. leptophyas Perkins Kauai
P. leptothrix Perkins Oahu
P. leucothorax Perkins Molokai
P. linearis Blackburn Kauai
P. longicornis Sharp Lanai
P. longisetus Perkins Oahu
P. maculatus Perkins Maui
P. malespretus Perkins Oahu
P. megalotarsus Perkins Maui
P. microtarsus Perkins Maui
P. moestus Perkins Oahu
P. moribundus Perkins Molokai
P. neglectus Perkins Kauai
P. obscurus chrysus Perkins Oahu
P. persimilis Perkins Maui
P. platygonioides Perkins Oahu
P. platygonias Perkins Oahu
P. robustus Blackburn Oahu
P. ruficollis Perkins Maui
P. scutatus Blackburn Kauai
P. sharpi Perkins Maui
P. squalidus Perkins Kauai
P. sternalioides Perkins Maui
P. swezeyi Perkins Oahu
P. tantali Perkins Oahu
P. tuberculiceps Perkins Maui
P. vulcanus Perkins Hawaii
P. xanthoxyli Perkins Oahu

DIPTERA:	Asteriidae:	Bryania bipunctate Aldrich Nihoa
	Dolichopodidae:	Campsicnemus mirabilis (Grimshaw) Oahu
	Drosophilidae:	Drosophila lanaiensis Grimshaw Lanai
	Empididae:	Chersodromia hawaiiensis Melander Oahu

HETEROPTERA:	Lygaeidae:	Metrarga obscura Blackburn Hawaii
		Neseis (Trachynysius) alternatus Usinger Kauai ex. Tetraplasandra kauaiensis
		N. (Leionysius) haleakalae (Perkins)
		Nesoclimacias lanaiensis (Kirkaldy) Molokai, Lanai
		Nesocryptias villosa (B. White) Kauai, Oahu
		Nysius frigatensis Usinger French Frigate Shoals
		N. fulla wayi Usinger Laysom, Lisianski, Pearl & Hermes
		N. neckerensis Usinger Necker
		N. nihoae Usinger Nihoa
		N. suffusus Usinger Nihoa
		Oceanides bryani Usinger Hawaii
		O. perkinsi Usinger Oahu
		O. rugosiceps Usinger Kauai ex Tetraplasandra kauaiensis
	Mesoveliidae:	Speovelia n. sp. Hawaii
	Miridae:	Cyrtopeltis (Engytatus) phyllostegiae Carvalho & Usinger Oahu
		C. (E.) n. sp. Oahu
		Kalania hawaiiensis (Kirkaldy) Lanai
		Kalania n. sp. Oahu
		Nesiomiris n. spp. Tetraplasandra
		Orthotylus n. sp. Oahu Abutilon
		Orthotylus n. sp. Oahu Urera kaalue
		Psallus n. sp. Niihau Myoporum
		Psallus n. sp. Oahu Urera kaalue
		Sarona n. sp. Kauai Myoporum
		Sulamita n. sp. Oahu Fagara
		Sulamita n. sp. Kauai Fagara kauaiensis
	Nabidae:	Nabis n. sp. Nihoa
	Reduviidae:	Empiocoris pulchrus (Blackburn) Oahu
		Nesidiolestes insularis Kirkaldy Oahu
		N. roberti Wygodzinsky Kauai
		N. selium Kirkaldy Hawaii
		N. n. sp. Hawaii (cavernicolas)
		Saicella smithi Usinger Maui
		S. usingeri Wygodzinsky Kauai
	Rhopalidae:	Ithamar annectans Van Duzee Oahu, Maui, Hawaii
		I. hawaiiensis Kirkaldy all islands

HOMOPTERA:	Cixiidae:	Oliarus consimilis Giffard Kauai
		O. discripans Giffard Oahu
		O. lihue Giffard Kauai
		O. myoporicola Giffard Oahu ex Myoporum
		O. priola Fennal Maui
		O. lanaiensis Giffard Lanai
	Delphacidae:	Nesorestias Filicicola Kirkaldy Oahu ex Cibotium
		Nesosydne acuta (Muir) Maui ex Cyrtandra
		Nesosydne bridwelli (Muir) Maui ex Argyroxiphium virescens
		Nesosydne cyrtandrae Muir Maui ex Cyrtandra
		N. cyrtandricola Muir Hawaii ex Cyrtandra
		N. kuschei (Muir) Kauai ex Cyrtandra
		Nesodyne leahi (Kirkaldy) Oahu ex Lipochaeta calycosa
		Nesosydne longipes (Muir) Maui ex Cyrtandra
		N. sulcata (Muir) Maui ex Cyrtandra
		Nesosydne sp. (Muir) Maui ex Argyroxiphium
		Nesothoe gouldiae Kirkaldy Oahu ex Cyrtandra
HYMENOPTERA:	Bethylidae:	Sclerodermus nihoaensis Timberlake Nihoa
	Colletidae:	Nesoprosopio perkinsiana Timberlake Nihoa
	Encyrtidae:	Anagyrus n. sp. Necker
	Enpelmidae:	Enpelmus nihoaensis Timberlake Nihoa
	Sphecidae:	Deinomimesa hawaiiensis Perkins
		D. punae Perkins
		Ectemnius nesocrabro bidecoratus Perkins Hawaii
		E. (Oreocrabro) curtipes (Perkins) Hawaii
		E. (O.) fulvicrus (Perkins) Hawaii
		E. (Nesocrabro) giffardi Yoshimoto Hawaii
		E. (O.) haleakalae (Perkins) Maui
		Nesom kauaiensis Perkins
		N. perkinsi Yoshimoto
		N. imesa sciopteryx Perkins
	Vespidae:	Odynerus niihauensis Yoshimoto Niihau
		O. soror Perkins Niihau
LEPIDOPTERA:	Carposinidae:	Heterocrossa viridis Walsingham Oahu Cyrtandra
	Gelechidae:	Thyrocopa n. sp.
	Noctuidae:	Agrotis bryani (Swezey) Nihoa
		A. evanescens (Rothschild) Laysan
		A. fasciatus (Rothschild) Laysan
		A. kerri Swezey French Frigate Shouls
		A. laysancusis (Rothschild) Laysan
		A. proullaris Meyrick Laysan
		Helicoverpa confusa Hardwick main islands
		Hypena laysanensis (Swezey) Laysan

LEPIDOPTERA:	Noctuidae:	Helicoverpa minula Hardwick Lisianski
		H. pallida Hardwick Nohoa, Necker
		Chenopodium oahuense
	Gracilariidae:	Petrochroa neckerensis Swezey Necker
	Phycitidea:	Rhynchephestia rhabdotis Hampson Maui on
		Argyroxiphium sandwicense
	Pryalidae:	Healylepta laysanensis (Swezey) Laysan
		Margaronia cyanomichla Meyrick Oahu,
		Hawaii, Kauai, Molokai ex
		Pseudomorus brunoniana
		Margaronia exaula (Meyrick) Oahu, Hawaii,
		Maui, Molokai, Kauai, ex Rauwolfia spp.
		Omiodes asaphombra Meyrick Oahu, Molokai,
		Kauai ex Joinvillea adscendens
		Phlyctaenia iocrossa Meyrick Oahu, Maui,
		Kauai ex Cyrtandra
		Tamsica n. sp. Nihoa
	Pyranstidae:	Ocobia dryadopa (Meyrick) Laysan
	Sphingidae:	Tinostoma smaragditis (Meyrick) "Green
		Sphinx of Kauai"
		Celerio wilsoni perkensi Swezey Oahu
	Totricidae:	Capua oheoheana Swezey Kauai on
		Tetraplasandra kauaiensis
		C. pterotropiana Swezey Kauai on
		Tetraplasandra kauaiensis
		C. reynoldsiana Swezey Oahu on Reynoldsia
NEUROPTERA:	Hemerobiidae:	Nesothauma haleakalae Perkins Maui
		Pseudopsectra cookerrum Zimmerman Maui
		P. lobipennis Perkins Maui
		P. swezeyi Zimmerman Kauai
		P. usingeri Zimmerman Hawaii
	Myrmeleontidae:	Eidoleon perjurus (Walker) Oahu, Molokai
		Eidoleon n. sp. Kauai
	Pseudococcidae:	Clavicoccus erinaceus Ferris Nihoa ex
		Pritchardia
		C. tribilus Ferris Oahu
		Phyllococcus oahuensis (Ehrhorn) Oahu
		Pseudococcus peleae Beardsley Oahu
		P. n. sp. Necker
		P. n. sp. Laysan
ODONOTA:	Coenagrionidae,	
	Zygoptera:	Megalagrion blackburni McLachlan Molokai,
		Maui, Lanai and Hawaii
		M. jugorum (Perkins) Lanai, Maui
		M. oahuensis McLachlan Oahu

ORTHOPTERA:	Gryllidea:	Caconemobius schauinslandi (Alflan) Molokai
		C. n. sp.
		Leptogryllus deceptor Perkins Oahu
		Prognathogryllus elongatus Perkins Maui
		Thaumatogryllus variegatus Perkins Kauai
	Tettigoniidae:	Banza nihoae Hebard Nihoa
		Conocephaloides remotus (Walker) Maui, Lanai, Hawaii
STREPSIPTERA:	Elenchidae:	Elenchus melanias Perkins
THYSANURA:	Machilidae:	Machiloides heterpos (Silvestri) all islands
		M. perkinsi (Silvestri) Kauai
ZORAPTERA:		Zorotypus swezeyi Caudell Kauai
		ex Koa, Metrosideros, Straussia

Thysanura, Neuroptera, Heteroptera, Strepsiptera and Hymenoptera compiled by W. C. Gagne, editor.

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